Nutritional Assessment of Instant Poundo Yam from Yellow Yam (*Dioscorea Cayenensis*) Supplemented with Yellow Cassava (*Manihot Esculenta*) Flour

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Abstract

The major objective of this study was to investigate the nutritional properties of yellow yam flour supplemented with yellow cassava flour. Specifically, the study dertermined functional properties of the yellow yam and yellow cassava flour blends, pasting properties of the yellow yam and yellow cassava flour blends, effect of supplementation on the sensory properties of the instant pound yam paste produced from yellow yam flour supplemented with yellow cassava flour. Good quality yellow yam (*Dioscorea cayenensis*), tubers and yellow cassava (*Manihot esculenta*) and *UMUCASS38* roots were obtained from International Institute for Tropical Agriculture (IITA), Ibadan, Oyo State, Nigeria. Samples were prepared by appropriate methods. The flour blends were formulated and instant pounded yam flour prepared. Functional analysis and sensony evaluation were carried out. Results of the analysis show the following ranges; oil absorption capacity 70.25 - 85.63%; water absorption capacity 73.89-78.69%; bulk density 0.76- 1.59g/m^3; peak viscosity 158.36- 210.43 RVU; final viscosity 178.53- 277.15RVU; setback viscosity of cooked paste 51.53-72.54 RVU; pasting time 5.95- 8.65 min; breakdown viscosity of the cooked paste 8.75- 9.53RVU; pasting temperature 62.55- 67.13^{0}C; trough 152.46-180.16 RVU. The general acceptability of all the supplemented samples were highly rated (8.00 each) as compared to control sample which had the lowest (6.05) value. Commercial production of instant poundo yam from yellow yam and yellow cassava flours will serve as a strategy of alleviating the challenge of food insecurity in Nigeria.

Key words: Instant, Poundo, Yam, Yellow, Cassava, Flour, Supplement.

Introduction

Yam, which is the most important staple food in West Africa, after cereals belongs to the Dioscoreaceae family. Yam is perennial herbaceous vines cultivated for the consumption of their starchy tubers in many temperate and sub-tropical world regions. There are many varieties of yam species throughout the tropics. Yam, with appreciable contents of essential dietary nutrients, has been reported to have nutritional superiority when compared with other tropical root crops (Aninathan, Mohar& Maruthupandian, 2009).

Yam belongs to the semi perishable class of food due to its relatively high moisture content and vulnerability to gradual physiological deterioration after harvesting. However, yam can be processed into less perishable products as yam flour through a drying process. In West Africa, a major proportion of yam is eaten as boiled yam, roasted yam, fried yam, pounded yam and amala which is stiff glutinous dough. The most processed traditional yam product is flour (Abioye, Ogunlakin, Babarinde& Adeoti, 2008).

Yellow yam (*Dioscorea cayenensis*) has a yellow flesh, caused by the presence of carotenoids. It looks similar to the white yam (*Dioscorea rotundata*) in outer appearance. Its tuber skin is usually a firmer and less extensive groove. The yellow yam has a longer period of vegetation and a shorter dormancy period than the white yam (Dumont & Vernier, 2000).

Cassava (*Manihot esculenta*) is a tuberous starchy root crop of the family Euphorbiaceous (Kochlar, 1981). It is a popular crop worldwide and it is known for its drought tolerance and for thriving well on marginal soils. A very wide range cassava variety is grown worldwide depending on the locality.

The yellow cassava is a new, yellow-fleshed breed of one of the most popular root crops in the tropics (Nascimento, Fernandes, Mauro,& Kimura, 2007). Yellow cassava is grown for its high concentration of β-carotene, which is a precursor to vitamin A. Vitamin A deficiency (VAD) lowers immunity and makes children in particular susceptible to many childhood infections such as diarrhea, measles and various forms of eye infections.

Freshly harvested cassava roots start deteriorating almost immediately after harvest and can only last for three days. The form of preservation and reduction of post-harvest loss is immediate processing into shell stable products such as flour, chips, gari, and pellets etc. processing cassava into finished or semi-finished products often involves all or some of the following operation on the desired end products, peeling, washing, grating/chipping, dewatering/fermentation, pulverizing, sieving, and drying/frying (Quaye, Gayin, Yawson, & Plahar, 2009).

Yam and cassava are generally bulky and contain a lot of moisture which makes them to be highly perishable. Post-harvest losses may also occur due to mechanical damages, infections caused by decay-organisms and pest infections. To avoid these post-harvest losses the yam and cassava are processed into finished or semi-finished products.

Instant pounded yam flour is the product obtained when parboiled yam is dried and milled. The flour is reconstituted in hot water to a mash similar to when boiled yam is pounded manually. Instant Pounded Yam Flour (IPYF) is a more hygienic product with longer shelf-life, processed and devoid of drudgery which is associated with the traditional process (Federal Institute of Industrial Research, Oshodi (FIIRO, 2005).

Pounded yam is a special delicacy in most parts of Nigeria. It is a glutinous dough made by peeling the yam, cutting to pieces, boiling, pounding and kneading. For consumption, the dough is usually cut with the fingers, moulded in the palm, dipped into stew and swallowed without mastication.

Texture is one of the three main acceptability factors used by consumers to evaluate food, the other two being appearance and flavour (Bourne, 1990).Texture is an important index of quality of pounded yam and the textural qualities relevant to the product are springiness, cohesiveness (mould ability), hardness, smoothness and adhesiveness (stickiness).

Pasting characteristics of starches have been associated with cooking quality and texture of various food products (Moorthy, 2002, 1994).Pasting is the result of a combination of processes that follows gelatinization from granule rupture to subsequent polymer alignment, due to mechanical shear during the heating and cooling of starches.

Consumers do appreciate the variety of supplements such as plantain, cocoyam, sweet potato etc. that is usually added during the traditional production in order to improve its viscosity and texture(Malomo, Ogunmoyela, Adekoyeni, Jimoh, Oluwajoba & Sobanwa, 2012; Abulude & Ojediran, 2006).

The functional properties determine the application and use of food material for various food products. Eating quality of yam products is related to both physicochemical and pasting characteristics ofthe tubers. Different authors (Peroni, Rocha & Franco, 2006; Sahorè, Amani & Nemlin, 2005; Afoakwa & Sefa-Dedeh, 2002) have reported on physicochemical and pasting characteristics of yam. However, flour from yellow yam and yellow cassava blends has not been studied extensively. Studies on physicochemical and pasting properties of flour from yellow yam and yellow cassava blends would be useful enhancing utilization, demand and market value of the product.

However, fortification may affect the functional and pasting characteristics of flour oriented foods. The traditional method of making pounded yam which requires physical pounding with mortar and pestle is very laborious and in some cases unhygienic compare with instant pounded yam flour which is more hygienic product with a longer shelf-life devoid of drudgery associated with the traditional process and result in multiplicity of nutrients which can be exported.

In lieu of this and for the sake of convenience and to reduce drudgery associated with the preparation of pounded yam, it has become imperative to prepare the instant pounded yam from yellow yam flour supplemented with yellow cassava flour. The study was also undertaken to determine the potential usefulness of pasting characteristics of flour from yellow yam and yellow cassava blends as indicators of food textural quality in pounded yam. This would be useful in the commercial processing.

Objective of the Study

The major objective of this study was to investigate the nutritional properties of yellow yam flour supplemented with yellow cassava flour. Specifically, the study determined:

1. functional properties of the yellow yam and yellow cassava flour blends.
2. pasting properties of the yellow yam and yellow cassava flour blends.
3. effect of supplementation on the sensory properties of the instant pound yam paste produced from yellow yam flour supplemented with yellow cassava flour.

Materials and Methods

Plan of the Study: The study was carried out through the following procedures:

Sample Preparation: This was involved the following:

i. Good quality yellow yam (*Dioscorea cayenensis*) tubers and yellow cassava (Manihot esculenta) UMUCASS38 roots were obtained from International Institute for Tropical Agriculture (IITA), Ibadan Oyo.

ii. Yellow yam flour sample was produced using the method described by FIIRO (2005). The yam tubers were washed, peeled, sliced to 2-3 mm thickness and soaked in water contain 1% sodium met bisulphate for 5 minutes so as to arrest the browning reaction and placed in a sieve to remove the excess water after which the sliced yam was cooked for 30minites at 100^{0}C. The cooked slices of yam were removed and dried at 50^{0}C to a constant weight. The dried samples were milled into fine flour using an attrition milling machine. The flour was sieved (500μm mesh), and packaged in moisture proof polyethylene bags and labeled for analysis

iii. Yellow cassava flour sample was prepared by the method described by Babajide, Oyewole& Obadina,(2006). The roots were peeled manually with stainless steel knife. The peeled roots were washed, sourced in lime (5%) for 30 minutes, washed again using clean water, grated, granulated, and oven dried at 5^{0}C. The oven dried cassava was milled (hammer milling machine), cooled and sieved (500µm mesh), and packaged in moisture proof polyethylene bags and labeled for analysis

***Blend formulation*:** This was done at different ratios of 90:10; 80:20; 70:30 and 60:40% of yellow yam flour and yellow cassava flour respectively. The flour blends were labeled as follows: YY (100% yellow yam flour); $YYYC_1$ (90% yellow yam flour and 10 yellow cassava flour); $YYYC_2$ (80% yellow yam flour and 20% yellow cassava flour); $YYYC_3$ (70% yellow yam flour and 30% yellow cassava flour) and $YYYC_4$ (60% yellow yam flour and 40% yellow cassava flour).

***Preparation of instant pounded yam flour*:** A quantity of each blend was poured in boiling water and stirred continuously till it gelatinizes into thick dough. A little quantity of water was added to allow the blend to cook properly (10 minutes). The paste was stirred till properly cooked (Babajide, Oyewole& Obadina, 2006; FIIRO, 2005).

***Functional Analysis*:** The following functional analysis were carried out:

i. Water/Oil Absorption Capacity: This is the quantity of water required to mix dough to a standard consistency. It was determined as described by Onwuka (2004).
ii. Bulk Density: This is the density of the bulk material as a result of tapping solids materials poured into a container. It was carried out as reported by Onwuka (2004).
iii. Pasting properties are functional properties relating to the ability of an item to act in paste-like manner. It was determined with a Rapid Visco Analyzer (RVA). (Newport scientific, 1998).

Sensory Evaluation:

***Instrument for Data Collection*:** The samples were coded and validated questionnaire made up of quality evaluation for flavor, texture, colour and general acceptability was used. Quality ratings were based on a 9-point descriptive hedonic scale with 9 (like extremely) being the highest score and 1(dislike very much) the least score (Ihekoronye & Ngoddy, 1985).

***Panel of Judges*:** The population was made up of ten (10) students of Food Science and Technology, Federal University Oye Ekiti, Ekiti State. The purposive sampling technique was adopted in the selection of the panel of judges because the students have better knowledge of food than other students and would therefore give better interpretation on what would be required on them.

Statistical Analysis: Means were compared using test of significant difference (Steel & Torrie, 1980). Test of significant ($P<0.05$) difference among the treatments were determined by Analysis of Variance (ANOVA) as described by Steel, Torrie& Diekey, (1997).

Results

The following findings were made:
(1)Effect of supplementation on functional properties of yellow yam and yellow cassava flour blends. See Table 1. (2)Effect of supplementation

on pasting properties of yellow yam and yellow cassava flour blends.See Table 2.

(3) Mean sensory scores of instant pound yam paste. See Table 3.

Table 1: Functional Properties of Instant Pounded Yam Produced from Yellow Yam and Yellow Cassava Flour Blends

Samples	OAC (%)	WAC (%)	BD (g/m^3)
YY	$85.63^a \pm 0.01$	$78.69^a \pm 0.0$	$0.76^e \pm 0.01$
YYYC1	$82.96^a \pm 0.01$	$77.84^b \pm 0.0$	$0.85^d \pm 0.01$
YYYC2	$80.13^a \pm 0.03$	$76.44^c \pm 0.0$	$0.98^c \pm 0.01$
YYYC3	$72.35^d \pm 0.01$	$75.71^d \pm 0.0$	$1.14^b \pm 0.01$
YYYC4	$70.25^e \pm 0.01$	$73.89^e \pm 0.0$	$1.59^a \pm 0.01$

Values are means ± Standard Deviation from triplicate determinations. Means with different superscripts within the same column are significantly different at (P<0.05).
KEY:OAC = Oil Absorption Capacity, WAC = Water Absorption Capacity, BD = Bulk Density.
YY = 100% Yellow Yam Flour, YYYC1 =90% Yellow Yam Flour: 10% Yellow Cassava Flour YYYC2, = 80% Yellow Yam Flour: 20% Yellow Cassava Flour, YYYC3 = 70% Yellow Yam Flour: 30% Yellow Cassava Flour, YYYC4 = 60% Yellow Yam Flour: 40% Yellow Cassava Flour

Table1 shows some functional properties of instant pounded yam produced from yellow yam and yellow cassava flours blends. The OAC and WAC of the blends reduced with increase in the proportion of the yellow cassava. At each level of supplementation the BD of the blends become denser than the control.

Table 2: Pasting Properties of Instant Pounded Yam Produced from Yellow Yam and Yellow Cassava Flour Blends

Samples	Peak Viscosity (RVU)	Final Viscosity (RVU)	Set-Back Viscosity (RVU)	Pasting Time (Min)	Breakdown Viscosity (RVU)	Pasting Temperature (C)	Trough Viscosity (RVU)
YY	$158.36^a \pm 0.0$	$178.53^e \pm 0.01$	$51.53^e \pm 0.01$	$5.95^e \pm 0.00$	$8.75^e \pm 0.00$	$62.55^e \pm 0.0$	$152.46^e \pm 0.0$
YYYC1	$169.53^d \pm 0.0$	$197.25^d \pm 0.01$	$61.47^d \pm 0.01$	$6.23^d \pm 0.00$	$8.92^d \pm 0.00$	$63.45^d \pm 0.0$	$159.84^d \pm 0.0$
YYYC2	$179.46^c \pm 0.0$	$235.62^c \pm 0.01$	$68.61^c \pm 0.01$	$7.12^c \pm 0.00$	$9.45^c \pm 0.00$	$65.50^c \pm 0.0$	$167.25^c 0.0$
YYYC3	$195.29^b \pm 0.0$	$257.82^e \pm 0.01$	$69.32^e \pm 0.01$	$7.82^b \pm 0.00$	$9.82^b \pm 0.00$	$66.83^b \pm 0.0$	$171.26^b \pm 0.0$
YYYC4	$210.43^a \pm 0.0$	$277.15^a \pm 0.01$	$72.54^e \pm 0.01$	$8.65^a \pm 0.00$	$9.93^a \pm 0.00$	$67.13^a \pm 0.0$	$180.16^a \pm 0.0$

Values are means ± Standard Deviation from triplicate determinations. Means with different superscripts within the same column are significantly different at (P<0.05).
KEY: OAC = Oil Absorption Capacity, WAC = Water Absorption Capacity, BD = Bulk Density.
YY = 100% Yellow Yam Flour, YYYC1 =90% Yellow Yam Flour; 10% Yellow Cassava Flour YYYC2, = 80% Yellow Yam Flour: 20% Yellow Cassava Flour, YYYC3 = 70% Yellow Yam Flour: 30% Yellow Cassava Flour, YYYC4 = 60% Yellow Yam Flour: 40% Yellow Cassava Flour

Table 2 shows some pasting properties of instant pounded yam produced from yellow yam and yellow cassava flours blends. The peak viscosity of the instant pounded yam blends ranged from 158.36 RVU for YY to 210.43 RVU for $YYYC_4$. The final viscosity of the instant pounded yam blends ranged from 178.53 to 277.15RVU with sample $YYYC_4$ having the highest final viscosity. The setback or viscosity of cooked paste of the yellow yam supplemented with yellow cassava flours ranged from 51.53RVU for sample YY to 72.54 RVU of sample $YYYC_4$. The pasting time of the samples ranges from 5.95 minutes to 8.65 minutes. Supplemented sample $YYYC_4$ had the highest pasting time, while sample YY had the lowest of 5.95 minutes. Breakdown viscosity ranged from 8.75RVU to 9.53RVU. The pasting temperature ranged from 62.55°C for sample YY to 67.13°C for sample $YYYC_4$. The trough values increased from 152.46 RVU for sample YY to 180.16 RVU for sample $YYYC_4$.

Table 3: Sensory Scores of Instant Pounded Yam made from Yellow Yam and Yellow Cassava Flours

	Mean sensory scores					
Samples	Appearance	Aroma	Taste	Texture	Mould ability	General Acceptability
YY	$8.00^a±0.85$	$7.00^b±0.91$	$7.00^b±0.80$	$6.01^c±0.24$	$6.05^c±0.43$	$6.30^c±0.98$
YYYC1	$8.05^a±0.76$	$7.30^b±0.47$	$7.30^b±0.70$	$7.40^b±0.15$	$8.00^b±0.68$	$8.00^a±0.99$
YYYC2	$7.75^b±0.64$	$7.00^b±0.96$	$7.40^b±0.90$	$7.42^b±0.14$	$8.04^b±0.82$	$8.02^a±0.67$
YYYC3	$7.30^b±0.80$	$7.50^a±0.68$	$8.00^a±0.62$	$7.48^b±0.15$	$8.00^b±0.69$	$8.00^a±0.50$
YYYC4	$7.75^b±0.85$	$8.00^a±0.72$	$8.01^a±0.85$	$8.00^a±0.25$	$8.85^a±0.94$	$8.01^a±0.65$

Values are means ± Standard Deviation from triplicate determinations. Means with different superscripts within the same column are significantly different at (P<0.05).
KEY: OAC = Oil Absorption Capacity, WAC = Water Absorption Capacity, BD = Bulk Density.
YY = 100% Yellow Yam Flour, YYYC1 =90% Yellow Yam Flour; 10% Yellow Cassava Flour YYYC2, = 80% Yellow Yam Flour: 20% Yellow Cassava Flour, YYYC3 = 70% Yellow Yam Flour: 30% Yellow Cassava Flour, YYYC4 = 60% Yellow Yam Flour: 40% Yellow Cassava Flour

Table 3 shows the mean sensory evaluation scores for instant pounded yam paste sample. A significant difference ($P < 0.05$) was noted in the appearance, aroma, taste, texture, mould ability and general acceptability of the sample.

Discussion

Functional properties of instant pounded yam produced from yellow yam and yellow cassava flours blends samples (Tables 1) showed that oil absorption capacity (OAC) and water absorption capacity (WAC) of the blends decrease with each level of supplementation in all the samples. The decrease in OAC could be attributed to the increase in the quantity of yellow cassava flour which may inhibit the disassociation of the protein that could occur on heating and also due to denaturation which unmask the non-polar residues from the interior of the protein network (Onimawo & Akubor, 2012). This implies that supplementation determines variation which affects the oil absorption of the instant pounded yam blends.

The significant decreased in WAC at (p<0.005) could also be attributed to the fact that WAC is dependent on the amount of water the food material is already holding and how much it can absorb in addition to attain saturation. More so a decrease in starch also contributes to less absorption of water. This is also in agreement with the results published by Oti, Alakali& Akpapunam, (2009).

At each level of supplementation the bulk density of the blends become denser than the control. Bulk density is influenced by particle size and the density of the flour.It is also germane in determining the packaging requirement, material handling and application in wet processing in the food industry (Karuna, Noel& Dilip, 1996).

Pasting properties of instant pounded yam produced from yellow yam and yellow cassava flours blends are presented in Tables 2. There was a significant (p<0.05) difference generally in the pasting profile values of the supplemented instant pounded yam blends. The significant difference indicated increase in peak viscosity with each level of supplementation from 10-40% of yellow cassava flour.Peak viscosity is the ability of starch to swell freely before their physical breakdown (Sanni, Kosoko, Adebowale, & Adeoye, 2004). High peak viscosity is an indication of high starch content (Osungbaro, 1990). It is also related to the water binding capacity of starch (Adebowale, Sanni & Awonorin,2005). The relatively high peak viscosity (233.43 RVU) exhibited by YYYC4 is indicative that the instant pounded yam produced had high gel strength and elasticity.

Breakdown viscosity which is the measure of the susceptibility or vulnerability of the cooked paste to disintegration or an index of the stability of starch ranged from 8.75RVU to 9.53RVU. There was significant (P< 0.05) difference between the samples. The through values increased from 152.46 RVU for sample YY to 180.14 RVU for sample $YYYC_4$. The lower the value of the trough, the more stable is the starch gel. The trough is the minimum viscosity value in the constant temperature phase of the RVA profile and measures the ability of paste to withstand breakdown during cooling.

The final viscosity of the instant pounded yam blends ranged from 178.53 to 277.15RVU with sample $YYYC_4$ having the highest final viscosity. Final viscosity is the most commonly used parameter to define the quality of a particular starch-based sample, as it indicates the ability of the material to form a viscous paste or gel after cooking and cooling as well the resistance of the paste to shear force during stirring (Adeyemi & Idowu, 1990).The setback or viscosity of cooked paste ranged from 51.53RVU for sample YY to 72.54 RVU of sample $YYYC_4$. High setback results in lower retro gradation during cooling of products (Kong, Zhu, Sui & Bao, 2015). It also lowers the staling rate of the products made from the flour (Adeyemi & Idowu, 1990). Starch retro gradation is usually accompanied by a series of physical changes such as increase viscosity and turbidity of pastes, gel formation, and exudation of water (Hoover, Hughes, Chung & Liu, 2010).

The pasting time of the samples ranges from 5.95 minutes to 8.65 minutes. Supplemented sample $YYYC_4$ had the highest pasting time, while sample YY had the lowest of 5.95 minutes According to Adebowale, Sanni & Awonorin, (2005) pasting time is the measure of the cooking time

The pasting temperature ranged from 62.55^{0}C (YY) to 67.13^{0}C ($YYYC_4$). Pasting temperature gives an indication of the gelatinization time during processing. It is the temperature at which the first detectable increase in viscosity is measured and is an index characterized by the initial change due to the swelling of starch (Emiola & Delarosa, 1981). Pasting temperature has been reported to relate to water binding capacity. A higher pasting temperature implies higher water binding capacity, higher gelatinization, and lower swelling property of starch due to a high degree of association between starch granules (Emiola & Delarosa, 1981; Numfor, Walter & Schwartz, 1996).

The appearance of supplemented instant pounded yam samples were closely the same but differed significantly ($P<0.05$) from control sample. This could be as a result of supplementation of Yellow Cassava flours. Samples YY, $YYYC_1$Yand YYC_2 had no significant difference ($p>0.05$) on one hand whereas sample $YYYC_3$and $YYYC_4$ were closely the same and also had the same aroma ($p<0.05$). On the average there was significant difference ($P<0.05$) in aroma of the blend samples. All the instant pounded yam samples were liked moderately except sample $YYYC_4$ which was liked very much. The aroma mean scores were observed to have reversed trend of the mean positions with those of appearance.

Though at confidence limit of 5%, the taste of instant pounded yam samples takes the same trend as appears with aroma, with samples $YYYC_3$ and $YYYC_4$where both had the same highest mean score of 8.0 and liked very much. There was significant

($P<0.05$) difference however, at average in the instant pounded yam mean taste values.

Samples $YYYC_1$, $YYYC_2$ and $YYYC_3$ had same mean values and were Like moderately. Only $YYYC_4$ was liked very much away from YY (control) which was liked slightly. This difference in viscosity - textural feel, could be explained as a result of the particles size of different categories of milling during processing into flours blends (Ahmed, Anjum &Butt., 2001).

The mean scores for mould ability of instant pounded yam supplemented with yellow cassava flours ranged from 8.00 of sample $YYYC_1$, $YYYC_3$ and$YYYC_4$ which had the highest mean mould ability values 'Liked very much' to 6.05 of sample YY(control) which was 'liked slightly'. Considering 5% confidence limit, there was significant ($P<0.05$) difference in the mould ability means score values of all the supplemented instant pounded yam samples (that showed no effect in supplementation) but away from the mean value of the control sample YY. This could be attributed to differential volume of water added during cooking of the paste of the samples and their textural particle sizes.

For general acceptability, it was found that all the supplemented instant pounded yam samples were far better preferred as compared to control. The mean scores for general acceptability of the supplemented instant pounded yam samples were very high. The high general acceptability could be due to enhanced processing methods employed in the studies. However, organoleptic properties which gave rise to unpleasant reduction in appearance acceptability of instant pounded yam could be attributed to poor colour interaction of the yellow yam and yellow cassava flour. All the supplemented samples were generally accepted at confidence limit of 5%.

Conclusion

The result showed that blending of yellow yam flour and yellow cassava flour generally improved the functional and pasting properties of the formulated samples. The OAC and WAC of the blends reduced with increase in the proportion of the yellow cassava. At each level of supplementation the BD of the blends become denser than the control. The formulated samples were found to have high viscosity, better texture, and generally acceptable for human consumption. However, sample from 80%: 20% (YYYC2) formulation is a potential blend owing to its high sensory appeal. Intensifying the production of this product will offer a strategy of alleviating the problem of food insecurity in Nigeria.

Recommendations

1. Further studies can be carried out on the anti-nutritional factors on the cassava flour to determine its limits if any for human consumption.
2. Studies can also be carried out to screen the physicochemical properties of the *D. cayenensis* that

can bring out the full potential of yellow yam for diverse uses.

3. Work should be carried out to ascertain the shelf-life of yellow yam flour in order to increase its storage stability and credibility for export.

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